

CALiPER

Snapshot Outdoor Area Lighting

Featuring **LED Outdoor Area & Roadway Luminaires**

LED Parking Garage Luminaires

LED Canopy Luminaires

Outdoor area lighting is a major contributor to nationwide energy use, and the market segment has been an important player in the transition to solid-state lighting. LED outdoor area luminaires must compete with other luminaires that are relatively energy efficient—compared to incandescent lamps, for example—making lifetime cost savings more challenging in a market that is dominated by retrofits and replacements. In well-designed LED luminaires' favor, however, are longer life and reduced maintenance, as well as much better color quality and operating characteristics than the primary incumbent source, high-pressure sodium (HPS), or metal halide.

LED outdoor area lighting has been a major component of the LED Lighting Facts® database since its inception, consistently being one of the categories with the most products. This Snapshot Report reflects the LED Lighting Facts database as of July 1, 2013, when LED outdoor area products comprised approximately 18% of the list. This report focuses on *outdoor area/roadway luminaires*, *parking garage luminaires*, and *canopy luminaires* (e.g., those used for gas station fuel pump areas), but also includes overall trends for all of the products listed by LED Lighting Facts. Although the aforementioned products are grouped together in this report as "outdoor area lighting" luminaires, they include products that are used in applications that are not strictly outdoors (e.g., parking garages).

After numerous pilot projects, many cities—both large and small—have initiated plans for rapid and widespread adoption of LED street lighting. Besides savings from reduced power draw, LED outdoor area lighting offers the potential for increased use of sensors and controls, which can result in even more financial benefits. Other potentially attractive features include better optical control for more uniform lighting, reduced backlight and/or light trespass, and preferable color quality. That said, as with most types of LED products, there is substantial variation in product quality, so specifiers must be especially careful about getting the right product for the application.



July 1, 2013

512 Manufacturers

316 Retailers & Distributors

280 Lighting Professionals

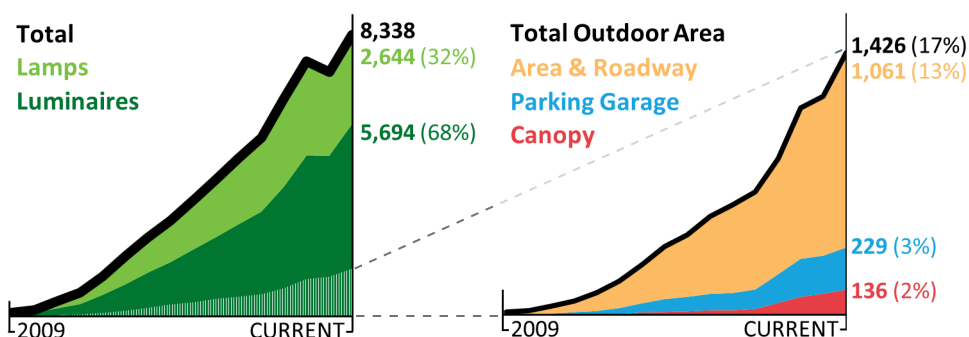
104 Energy Efficiency Programs

8,338 Total Active Products

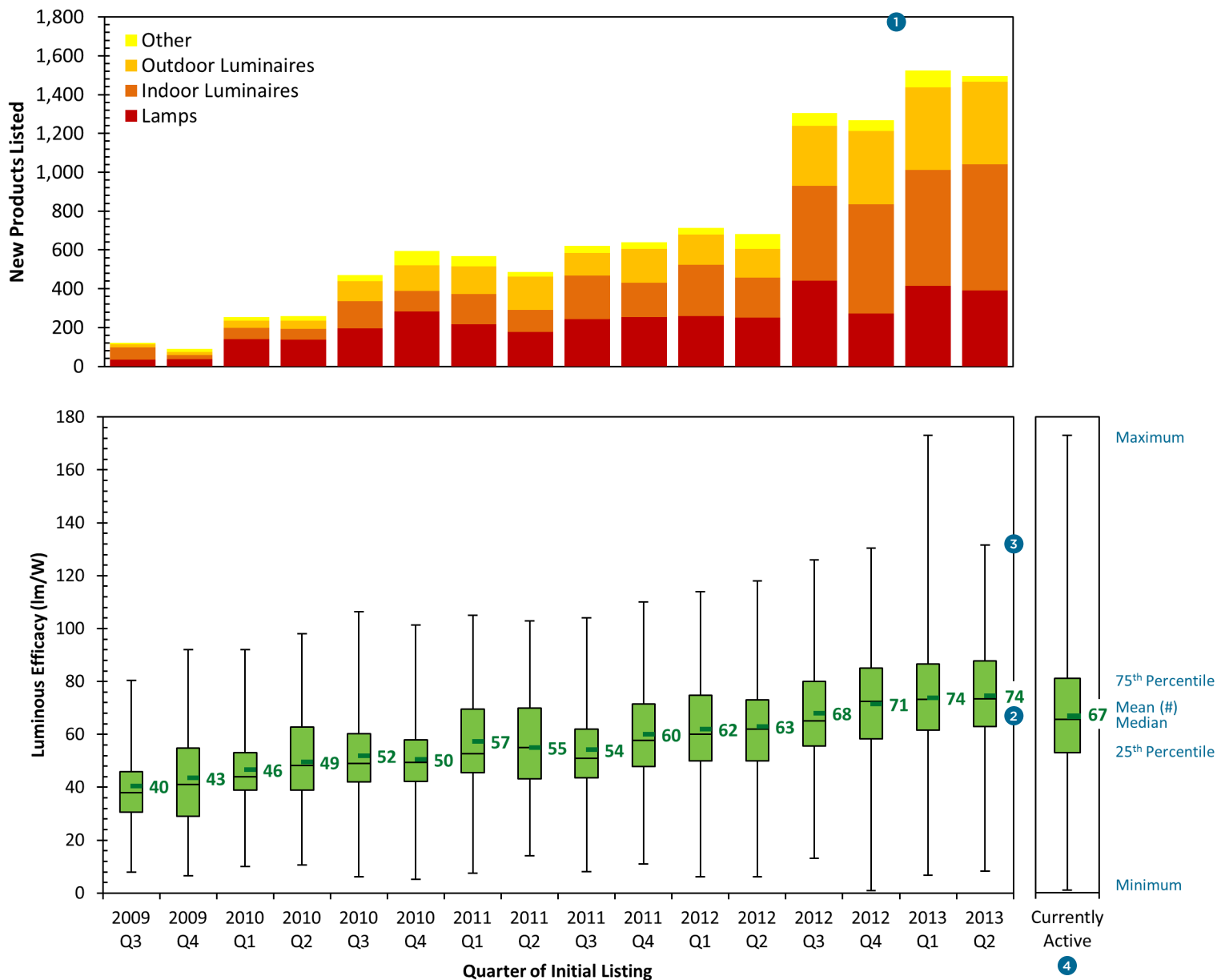
Report Highlights

- All three product categories evaluated included products that exceed 100 lm/W. At the same time, all three categories included products that are less than 50 lm/W. The majority of products emitted between 70 and 90 lm/W, which is generally as good as or better than the incumbent lighting systems.
- In the roadway category, where the incumbent technology is predominantly HPS, few LED products listed by LED Lighting Facts appear to be suitable alternatives to nominally 400 W luminaires. In general, fewer and fewer roadway products are listed as the lumen output range increases. This is one area of potential future growth for LED products.
- Although represented by a smaller sample, luminaires in the canopy category tended to have slightly higher efficacies, as well as higher color temperatures. Despite a lower quantity of products, there were more canopy luminaires over 100 lm/W than either of the other categories.
- LED outdoor area luminaires have a wide variety of color quality attributes, with CRIs mostly between 60 and 80, and CCTs generally between 4000 K and 6000 K. Generalized comparisons between color quality and efficacy may be misleading given the wide variety of individual product performance.

AT A GLANCE NUMBER OF PRODUCTS LISTED BY LED LIGHTING FACTS



All Products New Listings & Efficacy Performance by Quarter



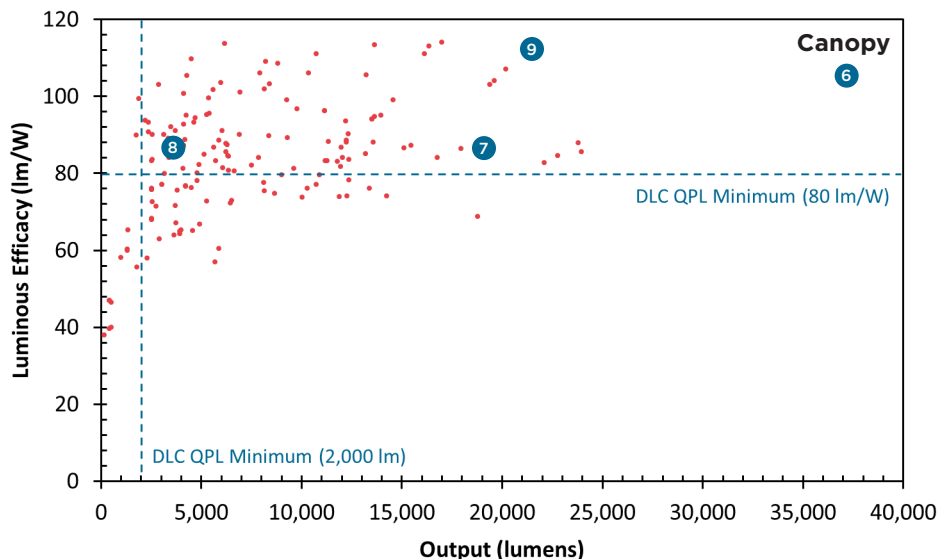
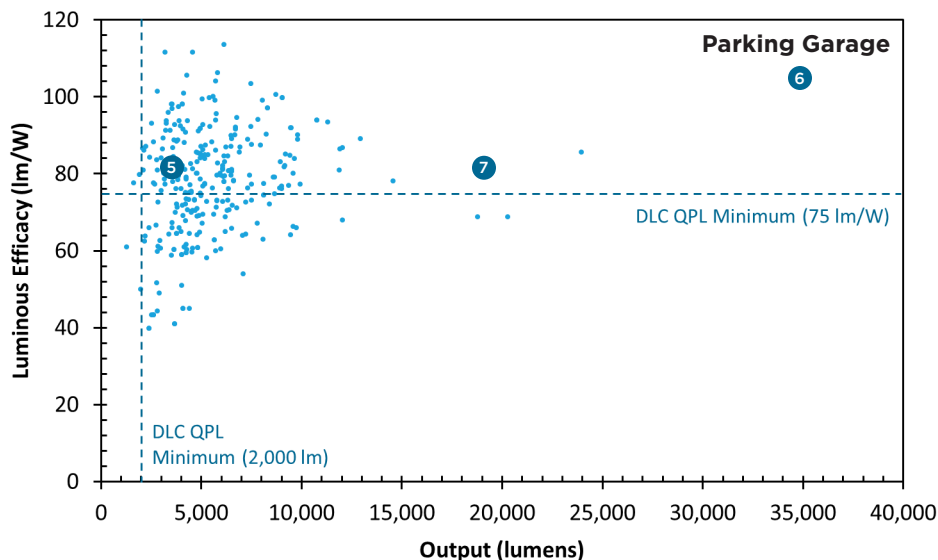
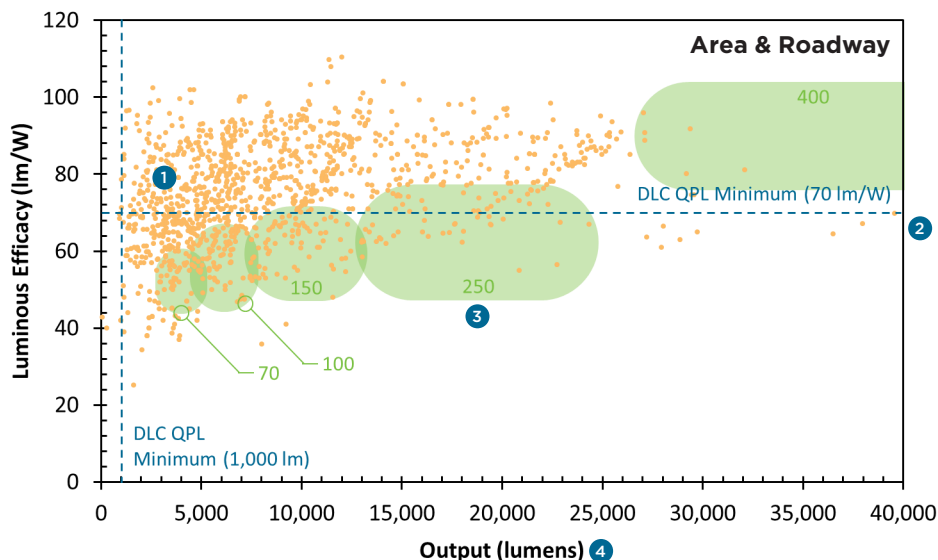
1 The growth of the LED Lighting Facts database has accelerated in the past year, with more than 1,000 new products added in each quarter. More than 60% of the 8,338 currently active products were added to the list within the past year. It is expected that this growth will continue, and it is likely to accelerate further when LED Lighting Facts' new family grouping policy is implemented.

2 Although the mean efficacy remained the same as in the first quarter of 2013 (74 lm/W), the first and third quartiles showed minor improvement. As has been the case throughout LED Lighting Facts' existence, the interquartile range (25% to 75%) remains small, indicating that many typical LED products perform similarly.

3 The maximum efficacy for products listed in the second quarter of 2013 returned to a level that matches the long-term trend. One anomalous product resulted in the higher-than-expected maximum efficacy in the first quarter of 2013.

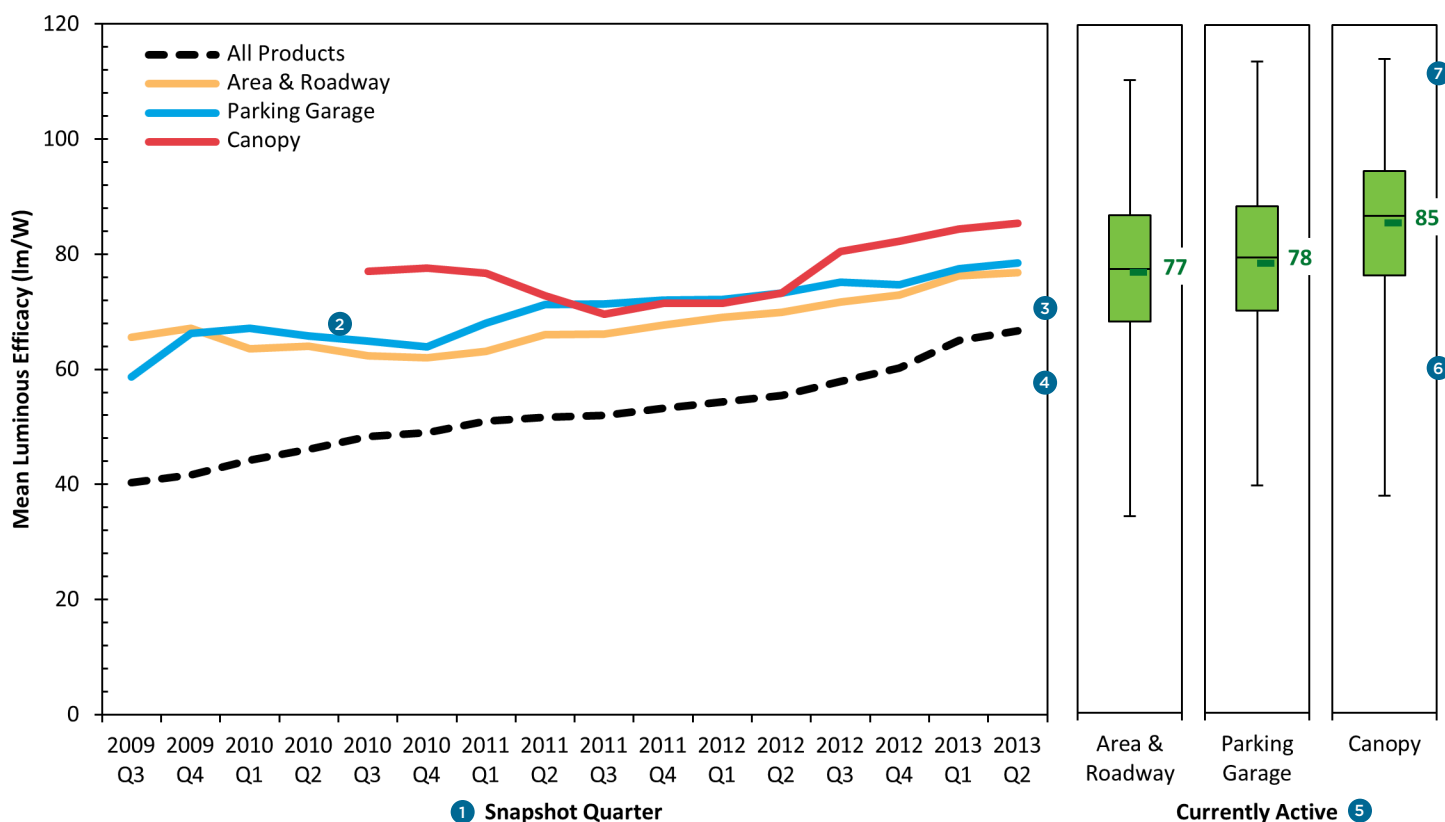
4 As would be expected given the age of some of the products that remain active in the database, the overall mean efficacy of currently active products (67 lm/W) remains slightly below the performance from recent quarters. However, it is higher than the mean efficacy for all products ever listed (64 lm/W), which indicates that lower efficacy products are being deactivated. It is also notable that the overall range in efficacy within the database remains extremely large.

Outdoor Area Lighting Efficacy & Output



- 1 A majority of the currently listed area and roadway luminaires (70%) meet both the efficacy and output criteria for the DesignLights Consortium® Qualified Products List (DLC QPL). Those that don't meet both criteria may still be more efficacious than the lower wattage HID products to which they are comparable.
- 2 One product emitting 53,474 lumens (65 lm/W) is not shown due to the scale of the chart.
- 3 The ranges shown in green correspond to the approximate total *luminaire* efficacy and output of HID products with the nominal lamp wattage indicated.
- 4 Due to different optical systems, equivalence in lumen output may not correspond to equivalence in delivered illuminance. This is true of all applications, but is especially relevant to outdoor area lighting.
- 5 Of the currently active parking garage luminaires in the LED Lighting Facts database, 65% meet the DLC QPL criteria for output and efficacy.
- 6 Due to the variety of lighting systems used in parking structures and for canopy lighting, no performance ranges are shown for conventional technologies.
- 7 For both parking garage and canopy luminaires, the range in lumen output is considerably less than for area and roadway luminaires—few listed products exceed 15,000 lumens. This is predominantly due to application differences, with more output needed when the luminaires are mounted higher or further apart (e.g., on poles).
- 8 Similar to the other categories, 68% of the listed canopy luminaire products meet the DLC QPL criteria for lumen output and efficacy.
- 9 Despite having the fewest products listed, the canopy luminaire category has more products with an efficacy above 100 lm/W (23; 17%) than either the parking garage or area and roadway luminaire categories.

Outdoor Area Lighting Efficacy Trend Comparison



1 This chart shows the mean efficacy as it would have appeared at the end of each quarter listed. That is, each point is a snapshot of the active products in the LED Lighting Facts database.

2 No canopy luminaires were listed prior to September 2010. The trend of decreasing mean efficacy through 2011 may simply be a result of a very small sample size; only 24 products were listed at the end of 2011.

3 All three product categories discussed in this report have shown similar increases in efficacy over time. Since 2009, the increase in efficacy for each category has been less than 20 lm/W (or approximately 25%). It has also been less than the combined average for all products listed by LED Lighting Facts.

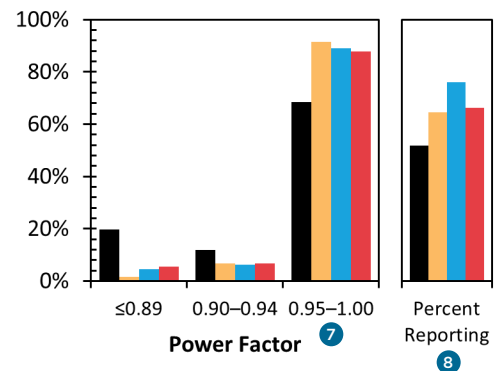
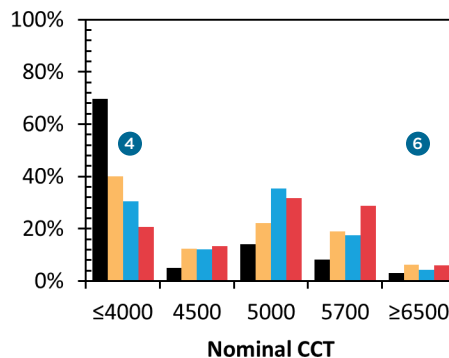
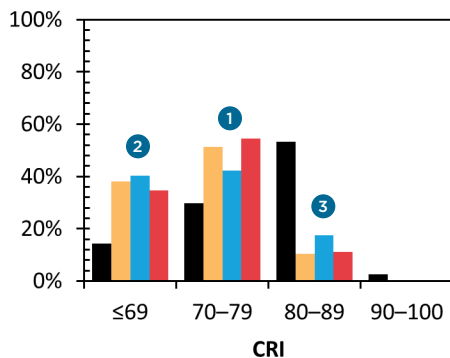
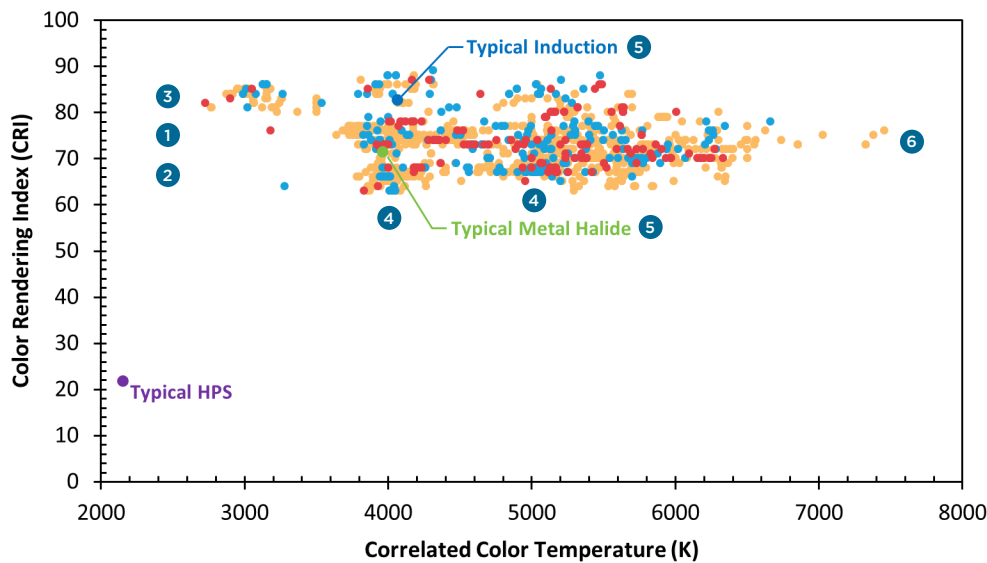
4 On average, all three outdoor area categories offer a substantially higher efficacy than for all products actively listed in the LED Lighting Facts database. This is likely necessary because LED outdoor area luminaires must compete with HID (and sometimes fluorescent) luminaires rather than incandescent or halogen.

5 The box plot characterization of currently active products in each of the three categories is similar. The canopy luminaires appear to be slightly more efficacious, but this could be a consequence of the smaller sample size and/or a higher mean CCT.

6 Typical luminaire efficacy for other types of outdoor area lighting is between 45 and 100 lm/W, depending on the source type, wattage, and luminaire efficiency. A majority of the competing LED products fall within or exceed that range. Additional gains in energy efficiency can potentially be achieved using more precise optical systems that are often available with LED products to better distribute light; these gains, if achievable, are specific to a given installation.

7 The maximum luminaire efficacy in each of the three categories is above 100 lm/W, which is substantially higher than other conventional technologies, including HPS, metal halide, and induction.

Outdoor Area Lighting Color Quality & Power Quality



1 In all three categories of outdoor area lighting products, the highest percentage of currently active products have a CRI in the 70s. This is comparable to many metal halide lamps used in similar applications. Although it is easily possible for LEDs to have a higher CRI, a CRI in the 70s is likely considered adequate for these applications by most specifiers.

2 More than 30% of products in each of the three outdoor area categories had a CRI less than 70. This performance level is substantially better than HPS, although it may be lower than some other alternatives. For many outdoor area lighting applications, CRI is not a primary concern.

3 A small but not insignificant proportion of the currently listed outdoor area products have a CRI in the 80s, which is comparable to induction or ceramic metal halide. No products had a listed CRI in the 90s.

4 Generally, the most common nominal CCTs were 4000 K and 5000 K, but a larger percentage of area and roadway luminaires had a CCT of 4000 K than for parking garage or canopy luminaires. In other words, the median CCT for parking garage luminaires (4954 K) and canopy luminaires (5133 K) was higher than for area and roadway luminaires (4632 K).

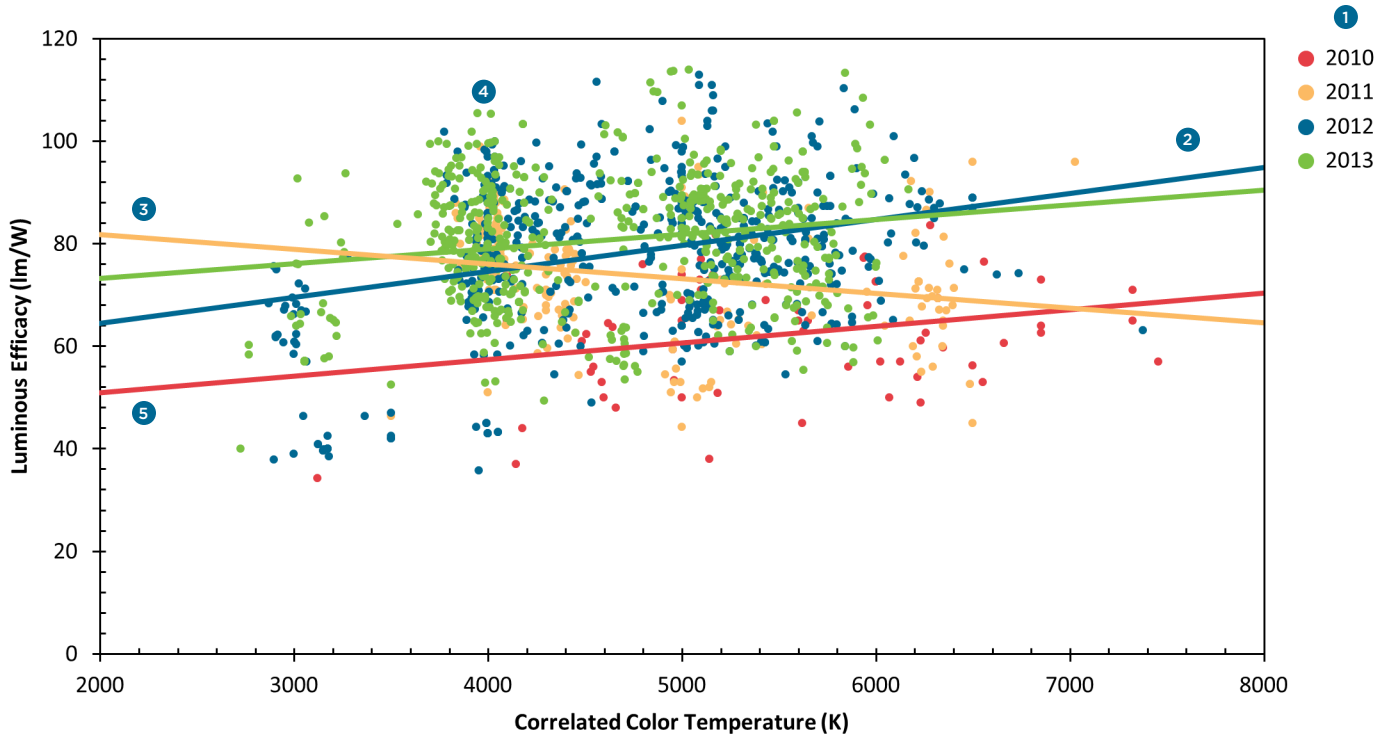
5 Both metal halide and induction lamps are available at different CCTs and CRIs. The examples shown are fairly common products, and simply serve as a general comparison.

6 A small percentage of products in all three categories had a nominal CCT of 6500 K or above. A few luminaires in the roadway category had CCTs above 7000 K. These are substantially higher than typically found for conventional alternatives.

7 A vast majority of all outdoor area lighting products *that reported the metric* had a power factor greater than 0.95.

8 Because it is not a required metric for the LED Lighting Facts program, many manufacturers did not list a value for power factor. It is not possible to conclusively determine how this affects the distribution of reported numbers, but manufacturers may be less likely to report low power factor values.

Outdoor Area Lighting Efficacy & Color Temperature



① All three outdoor area luminaire categories are grouped together for this chart, with the products divided based on the year in which they were listed.

② Because of the physics of the way they generate white light, today's LED products with a cooler color temperature are generally more efficacious, *if all other factors are held constant*. Trend lines for all but one of the past four years indicate that 6000 K products are, on average, about 10% more efficacious than 4000 K products, for example. This attribute was very important when LEDs were first introduced and trying to compete with incumbent technologies.

③ The trend line for 2011 has a slope that is not consistent with the other years. This could be due to a smaller sample size, which may not accurately characterize the population of all products—LED Lighting Facts is a voluntary program. Notably, the correlation coefficient for all of the trend lines is less than 0.10, indicating the linear trendlines are a poor fit. When considered as a whole, efficacy has a minimal relationship with CCT for all outdoor area products listed by LED Lighting Facts.

④ The poor correlation is indicative of the wide spread in data at any given CCT. Consequently it is easy to find an individual product at 4000 K that is more efficacious than a product at 6000 K. The axiom that higher CCT LED products are more efficacious is only applicable to a given product family from a single manufacturer, all other things equal.

⑤ Comparing the trend lines from one year to another reinforces the idea that, on average, the luminous efficacy of outdoor area LED luminaires is increasing. The increase has been mostly independent of CCT.

Discussion **How do the Outdoor Area Lighting products stack up?**

Across the three categories examined, products are available that exceed the efficacy of comparable conventional luminaires. Further, the majority of products could be considered equivalent or better than other alternatives, both in terms of efficacy and lighting quality. However, some products are unlikely to provide any energy savings compared to HPS, metal halide, induction, or fluorescent products.

With such a variety of available products, using average characteristics or generalizations may be misleading. For example, trend lines suggest that LED products with a higher CCT are more efficacious; however, this conclusion may only be (potentially) applied within a given product family from a single manufacturer. It is readily apparent that some 4000 K products are more efficacious than some 6000 K products. When selecting an outdoor area luminaire, each product should be evaluated on its own merit.

As a utilitarian product, outdoor area luminaires are often chosen based on financial considerations, rather than aesthetics or lighting quality—although these are still concerns—and in many cases, LED products are used as a retrofit or replacement for an existing system. Although it would be simple to look for a “one-for-one” replacement for a given product (e.g., a 100 W HPS street light) and then compare the wattage of the LED product to the wattage of the existing luminaire, such assessments may be ineffective. The distribution of light created by a luminaire can have a substantial effect on delivery efficiency and application efficacy, which are characteristics that can only be determined for a specific site. For example, in some cases an LED product may be able to save energy while providing the same delivered illuminance, even if the efficacy is not appreciably higher. The opposite may also be true. Control systems, which are better suited to LED products than HID products, may also allow for additional energy savings.

In all three of the product categories considered, some products are available with an efficacy greater than 100 lm/W. However, for roadway luminaires and parking garage luminaires, those products tend to not have the highest lumen output. For area and roadway luminaires, the data indicates that LED luminaires comparable to 400 W HID products may still be more limited in availability—although there certainly are options. In general, the lower the wattage, the more options are available. More options can lead to better products on the job site, but can also put a greater burden on the specifier to sift through product offerings and features.

Because they may cost more initially, specifiers should be careful to examine the complete performance of each LED product being considered, and understand its suitability for a given site or application. LED Lighting Facts provides only a subset of metrics that should be considered, and some other attributes, like discomfort glare, do not have a reliable metric. Mock-ups and pilot projects should be considered before widespread implementation of LED outdoor area lighting—much like for any new technology that has substantial variation between different products.

The Fine Print **About LED Lighting Facts Snapshot Reports**

Snapshot Reports analyze the dataset—or subsets—from DOE's LED Lighting Facts product list. They are designed to help lighting retailers, distributors, designers, utilities, energy efficiency program sponsors, and other industry stakeholders understand the current state and trajectory of the solid-state lighting market. Product classifications are at the discretion of the manufacturer, and Snapshot Reports generally reflect the raw data listed in the LED Lighting Facts database. Minimal action is taken to adjust for inconsistencies.

The LED Lighting Facts database is not a statistical sample of the overall market. LED Lighting Facts is a voluntary reporting program where manufacturers submit data for products tested in accordance with IES LM-79-08. Within any category, the data may be skewed by what is submitted, but also by the reporting practices of different manufacturers (e.g., reporting each small variation of a product). Given the broad nature of some of the predetermined categories, not all individual products may be directly comparable (i.e., the form factor may be substantially different). Despite these limitations, the LED Lighting Facts database is the largest of its kind, and is generally considered indicative of market trends. The product list includes a wide variety of product types, from manufacturers large and small, lighting industry veterans and brand new companies alike.

LED Lighting Facts and the Snapshot Reports focus on five core metrics: lumen output, input power, luminous efficacy, color rendering index, and correlated color temperature. Data for other performance metrics can be voluntarily submitted, and all data is available on the LED Lighting Facts website. Specifiers should thoroughly consider all aspects of performance when evaluating different products.

